14 p.

N63 23042

CODE-1

(NASA CR 51587;

OTS PRICE

XEROX $ 1.60 ph

MICROFILM $ 0.80 mf

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

SQT-8468

RE-ORDER NO. 62-690

; RML-3) OTS:

EVALUATION OF CRITICAL PROPERTIES OF SELECTED MATERIALS FOR ELECTRONIC PACKAGING PURPOSES

[monthly] Summary Report, ~~RML-3~~ [no. 3]
~~1 May 1962 through~~ 30 May 1962
1 June 1962 14 p

[8]

double code
JPL and
Redel

Contract bop:
don't index

JPL - PO -

Purchase Order No. F2-177911
Project No. 520-277

4742003

Research conducted for:
Calif. Inst. of Tech.,
Jet Propulsion Laboratory
4800 Oak Grove Avenue
Pasadena, California
CAI

Jay W. DeDapper (Redel, Inc)
Jay W. DeDapper
President

Redel INCORPORATED
Anaheim, California

10/14

110359

TABLE OF CONTENTS

EVALUATION OF CRITICAL PROPERTIES OF SELECTED MATERIALS FOR ELECTRONIC PACKAGING PURPOSES

I. INTRODUCTION

This is the third monthly report in a series documenting an evaluation under simulated space conditions of selected non-metallic materials, utilized in electronic equipment. During this period, most of the comparative ambient environment tests have been completed; a smaller portion of the vacuum tests made; and a somewhat larger portion of the ambient environment tests after vacuum and temperature soak cycles have been completed. The results are reported without comments or conclusions in this report; evaluation, deduction and recommendations will be reserved for the next (final) report. These data should be considered as preliminary and subject to change in retesting when the entire program is completed. Vacuum pressures are listed as nominal for ease of reporting in this monthly report only. The final report will report actual measured values which in all tests reported herein ranged from 10^{-4} to 10^{-6}mm Hg. Although the equipment is capable of operating at 10^{-7}mm Hg severe outgassing has been experienced with all the test samples. This has precluded the possibility of every test within the times provided required by the contract at 10^{-6}mm Hg.

II. MECHANICAL TESTS (Truesdail Laboratories subcontract except for Adhesion Tests at Redel)

A. Adhesive, Eccobond 55 w/No. 9 Catalyst (Emerson and Cuming)

1. Tensile Shear, ASTM D1002 (5 replications)
Samples solvent wiped; bonding and curing cycles as recommended by manufacturer

	Low	Average	High
1 ATM and 72°F			
Metal*-Metal	351 psi	463 psi	597 psi
Metal-Plastic**	382	503	665
Plastic-Plastic	1847	2076	2233
1 ATM and 300°F			
Metal-Metal	111 psi	146 psi	181 psi
Metal-Plastic	80	87	91
Plastic-Plastic	79	86	95
1 ATM and -40°F			
Metal-Metal	477 psi	545 psi	616 psi
Metal-Plastic	345	400	539
Plastic-Plastic	1537	1940	2347

2. Cleavage Strength, ASTM D1062-51 (5 replications)
Samples solvent wiped; bonding and curing cycles as recommended by manufacturer

	Low	Average	High
1 ATM and 72°F			
Metal*-Metal	477 psi	690 psi	1010 psi
Metal-Plastic**	149	389	580
Plastic-Plastic	613	717	869
1 ATM and 300°F			
Metal-Metal	86 psi	92 psi	169 psi
Metal-Plastic	14	32	54
Plastic-Plastic	34	55	84
1 ATM and -40°F			
Metal-Metal	496 psi	621 psi	711 psi
Metal-Plastic	432	632	931
Plastic-Plastic	300, 465, 703, 910, 980		

*Aluminum, 6061 S
**Epoxy-glass, Type GE

B. Conformal Coatings

1. Tuf-On 747S (Brooklyn Paint and Varnish)

a. Adhesion, Federal Test Method 141-6301 (3 replications)
Samples solvent wiped; curing cycles as recommended by manufacturer and as noted

	Cure Cycle	
	Room Temp	165°F
1 ATM-70°F		
On Metal*	Fail	Fail
On Plastic**	Pass	Fail
After 10^{-6} mm Hg nominal and 70°F for 24 hours (Tested at 70°F and 1 Atm)		
On Metal	Fail	Fail
On Plastic	Pass	Fail

2. Solithane 113 w/300 Catalyst (Thiokol)

a. Adhesion, Federal Test Method 141-6301 (3 replications)
Samples solvent wiped, curing cycles as recommended by manufacturer and as noted

	Cure Cycle	
	Room Temp	165°F
1 ATM-70°F		
On Metal*	Fail	Fail
On Plastic**	Pass	Pass
After 10^{-6} mm nominal and 70°F for 24 hours (Tested at 70°F and 1 Atm		
On Metal	Fail	Fail
On Plastic	Pass	Pass

*Aluminum 6061 ST
**Epoxy-glass, Type GE

C. Potting Compounds, Stycast 1090 w/No. 9 and No. 11 Catalysts (Emerson and Cuming)

1. Tensile Strength, ASTM D638 (5 replications)
Samples cast and machined to size; curing cycles as recommended by manufacturer and as noted

	Low	Average	High
1 ATM and 64°F			
Room temperature cure (Catalyst No. 9)	340 psi	370 psi	400 psi
212°F-2 hours cure (Catalyst No. 11)	317	354	391
1 ATM and 300°F			
Room temperature cure (Catalyst No. 9)	136	217	298
212°F-2 hours cure (Catalyst No. 11)	243	281	319
1 ATM and -40°F			
Room temperature cure (Catalyst No. 9)	2602	2881	3160
212°F-2 hours cure (Catalyst No. 11)	2486	2656	2826

D. Foams, Eccofoam FP w/12-6 Catalyst (Emerson and Cuming)
Eccofoam FPH w/12-6H Catalyst (high temperature)

1. Tensile Strength, ASTM D638 (5 replications)
Samples machined to size; curing cycles as recommended by manufacturer

	Low	Average	High
1 ATM and 72°F			
FP	127 psi	144 psi	161 psi
FPH	191	166	141
1 ATM and 165°F			
FP	-	< 1 psi	-
FPH	143	157	171
1 ATM and -40°F			
FP	152	181	210 psi
FPH	269	304	339

III. ELECTRICAL TESTS

A. Adhesive, Eccobond 55 w/No. 9 Catalyst (Emerson and Cuming)

1. Resistivity, ASTM D257 (average of 3 replications)
Samples cured as recommended by manufacturer

	1 ATM	10^{-6}mm Hg Nominal	At 70°F-1 Atm, after 24 hours at 10^{-6}mm Hg and temperature noted
a. Volume (ohms/cm^3)			
+ 70°F	7×10^{14}	6.4×10^{14}	6.4×10^{14}
+ 300°F	2.2×10^{14}		3×10^{14}
b. Surface (ohms/cm)			
+ 70°F	7.4×10^{11}	6.1×10^{11}	6×10^{11}
+ 300°F	2×10^{11}		2.5×10^{11}

B. Conformal Coatings

1. Solithane 113 w/Catalyst 300 (Thiokol)
Curing cycle as recommended by manufacturer

a. Resistivity ASTM D257 (average of 3 replications)

	1 Atm	10^{-6} mm Hg Nominal	At 70°F-1 Atm after 24 hours at 10^{-6} mm Hg and temperature noted
1. Volume (ohms/cm^3)			
+ 70°F	9.6×10^{12}	9.8×10^{12}	10.2×10^{12}
2. Surface (ohms/cm)			
+ 70°F	9.9×10^{14}	10.2×10^{14}	11.1×10^{14}

b. Capacitance, ASTM D150 (average of 3 replications)

1. Dielectric Constant			
+ 70°F 60 cyc/sec	3.9	4.1	3.97
+ 70°F 10^6 cyc/sec	3.89	3.56	3.56
2. Dissipation Factor			
+70°F 60 cyc/sec	0.084	0.085	0.085
+ 70°F 10^6 cyc/sec	0.024	0.024	0.024

C. Potting Compound, Stycast 1090 w/Catalyst No. 9 and No. 11 (Emerson and Cuming)

1. Resistivity, ASTM D257 (average of 3 replications)

	1 Atm	10^{-6} mm Hg Nominal	At 70°F-1 Atm after 24 hours at 10^{-6} mm Hg and temperatures noted
a. Volume (ohms/cm^3)			
+70°F Room temperature cure (Catalyst No. 9)	4.9×10^{13}	-	-
212°F-2 hrs. cure (Catalyst No. 11)	4.2×10^{13}	5×10^{13}	4.8×10^{13}
+300°F Room temperature cure (Catalyst No. 9)	2×10^{13}	-	-
212°F-2 hrs. cure (Catalyst No. 11)	1.8×10^{13}	2×10^{13}	4×10^{13}
b. Surface (ohms/cm)			
+70°F Room temperature cure (Catalyst No. 9)	7.9×10^{12}	-	-
212°F-2 hrs. cure (Catalyst No. 11)	6.5×10^{12}	7×10^{12}	6.7×10^{12}
+300°F Room temperature cure (Catalyst No. 9)	2.4×10^{12}	-	-
212°F-2 hrs. cure (Catalyst No. 11)	2.1×10^{12}	2.5×10^{12}	6.1×10^{12}

2. Capacitance, ASTM D150 (average of 3 replications)

	1 Atm	10^{-6} mm Hg Nominal	At 70°F and 1 Atm after 24 hours at 10^{6} mm Hg and temperatures noted
a. Dielectric Constant			
Room temperature cure (Catalyst No. 9)			
+ 70°F			
60 cyc/sec	-	-	-
10^{6} cyc/sec	1.33	1.34	1.34
+ 300°F			
60 cyc/sec	-	-	-
10^{6} cyc/sec	1.15	+	1.29
212°F-2 hrs. cure (Catalyst No. 11)			
+ 70°F			
60 cyc/sec	1.4	1.49	1.39
10^{6} cyc/sec	1.2	1.29	1.27
+ 300°F			
60 cyc/sec	1.47	1.63	1.51
10^{6} cyc/sec	1.35	1.4	1.29
b. Dissipation Factor			
Room temperature cure (Catalyst No. 9)			
+ 70°F			
60 cyc/sec	-	-	-
10^{6} cyc/sec	0.015	0.014	0.015
+ 300°F			
60 cyc/sec	-	-	-
10^{6} cyc/sec	0.014	-	0.016
212°F-2 hrs. cure (Catalyst No. 11)			
+ 70°F			
60 cyc/sec	0.015	0.015	0.017
10^{6} cyc/sec	0.015	0.015	0.017
+ 300°F			
60 cyc/sec	0.016	0.016	0.015
10^{6} cyc/sec	0.014	0.015	0.015

IV. PHYSICAL TESTS

A. Adhesive, Eccobond 55 w/No. 9 Catalyst (Emerson and Cuming)
Solid specimens cast and cured according to recommended procedures of manufacturer

1. Moisture Absorption, ASTM D570 (average of 3 replications)

	Tested at 70°F	Tested at 165°F
At 1 Atm.	0.54%	0.57%
After 24 hrs. at 10^{6} mm Hg nominal and 70°F	0.11%	0.11%

B. Conformal Coating

1. Tuf-On 747S (Brooklyn Paint and Varnish)

a. Moisture Absorption, ASTM D570 (average of 3 replications)

	Tested at 70°F	Tested at 165°F
At 1 Atm		
Room temperature cure	0.32%	0.0%
165°F cure	0.31%	-0.23%
After 24 hrs. at 10^{-6} mm Hg nominal and 70°F		
Room temperature cure	0.03%	0.16%
165°F cure	0.08%	-0.44%

2. Solithane 113 w/300 Catalyst (Thiokol)

a. Moisture Absorption, ASTM D570 (average of 3 replications)

	Tested at 70°F	Tested at 165°F
At 1 Atm		
Room temperature cure	1.44%	1.44%
165°F cure	1.27%	1.08%
After 24 hrs. at 10^{-6} mm Hg nominal and 70°F		
Room temperature cure	1.6%	0.8%
165°F cure	0.45%	1.0%

C. Potting Compound Stycast 1090 w/Catalyst No. 9 and Catalyst No. 11 (Emerson and Cuming)

1. Moisture Absorption, ASTM D570 (average of 3 replications)

	Tested at 70°F	Tested at 165°F
a. At 1 Atm		
Room temperature cure (Catalyst No. 9)	1.75%	2.3%
212°F-2 hrs. cure (Catalyst No. 11)	2.3%	3.2%
b. After 24 hrs. at 10^{-6} mm Hg nominal and 70°F		
Room temperature cure (Catalyst No. 9)	0.35%	1.76%
212°F-2 hrs. cure (Catalyst No. 11)	1.01%	3.08%

2. Thermal Expansion, ASTM D696 (average of 3 replications)

	Tested at -40°F to + 70°F	Tested at + 70°F to + 300°F
a. At 1 Atm		
Room temperature cure (Catalyst No. 9)	1.59×10^{-5}	1.52×10^{-5} in/in°F
212°F-2 hrs. cure (Catalyst No. 11)	1.23×10^{-5}	1.65×10^{-5}

3. Thermal Conductivity, ASTM C177-45 (average of 3 replications)

	Tested at -40°F to + 70°F	Tested at + 70°F to + 300°F
a. At 1 Atm		
Room temperature cure (Catalyst No. 9)	6.0×10^{-3}	8.2×10^{-3} BTU/in^2/°F/hr/in.
212°F-2 hrs. cure (Catalyst No. 11)	7.5×10^{-3}	8.6×10^{-3}
b. After 24 hrs. at 10^{-6} mm Hg nominal and 70°F		
Room temperature cure (Catalyst No. 9)		7.6×10^{-3}
212°F-2 hrs. cure (Catalyst No. 11)		1.2×10^{-3}

D. Foams, Eccofoam FP w/Catalyst 12-6 (Emerson and Cuming)
Eccofoam FPH w/Catalyst 12-6H (high temperature)

1. Moisture Absorption, ASTM D-570 (average of 3 replications)

	Tested at 70°F	Tested at 165°F
a. At 1 Atm		
FP	84%	128%
FPH	50	57
b. After 24 hours at 10^{-6} mm Hg nominal and 70°F		
FP	104	700
FPH	59	124

2. Thermal Expansion, ASTM D696 (average of 3 replications)

	Tested at -40°F to + 70°F	Tested at + 70°F to + 165°F
a. At 1 Atm		
FP	2.8×10^{-5} in/in/°F	2.1×10^{-5} in/in/°F
FPH	2.1×10^{-5}	0.8×10^{-5}
b. After 24 hours at 10^{-6} mm Hg nominal and 70°F		
FP	1.8×10^{-5} in/in/°F	2.6×10^{-5} in/in/°F
FPH	1.6×10^{-5}	0.3×10^{-5}
c. At 10^{-6} mm Hg nominal and 70°F		
FP		3.2×10^{-5}

3. Thermal Conductivity ASTM C 177-45 (average of 3 replications)

	Tested at -40°F to + 70°F	Tested at + 70°F to + 300°F
a. At 1 Atm		
FP	-	9.0×10^{-3} BTU/in^2/°F/hr/in.
FPH	1.2×10^{-3}	5.4×10^{-3}
b. After 24 hours at 10^{-6} mm Hg nominal and 70°F		
FP	-	7.4×10^{-3}
FPH	-	7.2×10^{-3}

4. Density ASTM D1564 (average of 2 replications)

	Tested at 70°F	Tested at 300°F
a. At 1 Atm		
FP	0.0833 gms/cc 5.2#/ft^3	0.0883 gms/cc
FPH	0.0854 5.3#/ft^3	0.0913 gms/cc